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May 31, 1996

By Hand Delivery

Richard M. Smith, Chief
Office of Engineering and Technology
Federal Communications Commission
2000 M Street, N.W., Room 480
Washington, D.C. 20554

Re: Request for Waiver of Part 18 Conducted Emission
Limits for an RF Lighting Device

Dear Dick:

We represent Fusion Lighting Inc. ("Fusion"), of Rockville, Maryland, the developer and manufacturer of a revolutionary lighting technology regulated under the Commission's Part 18 Rules. Pursuant to Section 1.3 of the Rules, Fusion seeks a waiver of the Part 18 conducted emission limits which may be applicable to its lighting products. Fusion's justification for this request is set forth below.

Summary of Waiver Request

The Department of Energy estimates that 25% of all energy usage in the U.S. is attributed to lighting, a technology that has changed little since the time of Edison. In recent years, a number of evolutionary RF-based lighting products have emerged with the promise to deliver low cost, high efficiency illumination for homes and work places. Fusion is the latest entrant in the RF lighting arena with a technology that is, by nearly any standard, revolutionary in what it has to offer.

Powered by a 2.45 GHz magnetron, the Fusion lamp is over four times more efficient than incandescent lighting yet has none of the draw backs of high intensity discharge (HID) lamps -- making it perhaps the greatest lighting breakthrough in nearly 100 years. In terms of its EMC characteristics, the Fusion lamp is sui generis under the Commission's Part 18 Rules; that is, while it meets the definition of an RF lighting device, its spectrum is nearly identical to that of a microwave oven, creating the regulatory dilemma for which Fusion now seeks a rule waiver.

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The Commission's current standards for RF lighting devices are over a dozen years old, having been modeled on low frequency products that were thought to behave similarly to digital devices. Accordingly, these devices are not subject to emission limits above 1 GHz and are required to meet very stringent conducted limits below 30 MHz. By contrast, the microwave oven standards, which are over 30 years old and based on high frequency sources, have no conducted limits below 30 MHz. The Fusion lamp complies easily with the microwave oven rules, but cannot meet the RF lighting device rules without creating potential safety hazards to end users. Fusion submits that a waiver of Part 18 is needed to avoid this "Hobson's Choice" of EMC compliance versus safety.

In addition, because Fusion uses the same microwave source^{1/} as ovens, a rule waiver would put its lamps on the same regulatory footing with other high frequency ISM band emitters. Moreover, the potential interference concerns raised by Fusion's request are demonstrably negated by the millions of incident-free microwave ovens currently on the market. In the wake of the General Electric Company's recent waiver of the Part 18 conducted emission limits for its RF-lighting device,^{2/} Fusion submits that the Chief Engineer has the requisite delegation of authority to grant Fusion's request.

Legal Analysis

I. The Fusion Lamp Represents a Revolutionary Lighting Technology Which is Threatened by Outdated Commission Rules

A. The Fusion Lamp

For many years, incandescent bulbs have been the low cost, but notoriously inefficient, "lighting of choice" for homes and workplaces. In recent times, the replacement of incandescent

^{1/} As presently designed, the Fusion lamp uses a 2.45 GHz magnetron for its microwave source; however, Fusion anticipates that "cleaner" spectrum sources may be available in the future from manufacturers of klystron and solid state devices. Fusion's conducted emission problems will be the same, however, regardless of the microwave source employed. See Section III, infra.

^{2/} See Order Granting Limited Waiver, infra note 5, at 5.

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bulbs with fluorescent and HID lamps has greatly increased lighting efficiency and improved energy conservation. However, fluorescent lighting offers poor "color" and HID lamps have not caught on in many applications due to deficiencies in brightness, useful life, color and bulb reproducibility. Moreover, both technologies use mercury in their designs, creating serious disposal hazards under state and federal environmental laws.

In 1990, Fusion discovered that materials such as sulfur provide efficient, mercury-free sources of high quality light; however, sulfur was known to react with metal electrodes such that they only could be operated in an electrodeless discharge energized by RF or microwave energy. At the high power levels required for such lighting, Fusion determined that a 2.45 GHz magnetron would be the most economical solution.

In the Fusion lamp, microwaves in the 2.45 GHz ISM band are delivered to a spherical quartz bulb, approximately 40 mm in diameter, filled with argon and a small quantity of sulfur. The lamp cavity has been carefully designed to reduce the radiated microwave emissions from the system. The cavity is "matched" to the microwave source making the load very consistent during operation, causing the operating frequency to change very little and resulting in a relatively clean output spectrum. The lamps use microwave sources, similar to those found in many home microwave ovens, providing the microwave power to the bulb.

Recent testing reveals the Fusion lamp to operate at approximately 100 lumens/watt efficacy, as compared to 19 lumens/watt for incandescent bulbs and 75-80 lumens/watt for HID sources. Lamp lifetime is estimated to be 60,000 hours, with no degradation in either spectrum or emissions. The primary application for the Fusion lamp will be wide area lighting in factories, shopping malls, sports stadiums, warehouses, aircraft hangers, and exterior locations where large quantities of high quality, long-lived lighting are required. Fusion's initial product is intended to be a non-consumer lighting source, drawing power from the high voltage mains (220V). Commercial lamps are currently sold primarily to OEMs who assemble Fusion's light source component with a reflector made of metal, glass or other materials into a lighting system for end user sale.

B. Outdated Part 18 Rules

A vitally important public policy goal of the Commission is to strike a balance between the RF-based design

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needs of equipment manufacturers and the interference concerns of communications users. When a new RF technology emerges, these balancing functions are often put to the test. Rules that are too rigid, or out of date, tend to penalize manufacturers and deny the public the important benefits of new technologies. When these situations arise, it is incumbent on the Commission to revise its rules generally, or to waive them for the specific applications sought.

The Fusion lamp is a novel microwave-based technology which utilizes the same ISM bands used by millions of household and commercial microwave ovens. Were the Fusion lamp required to comply with the Part 18 limits applicable to ovens, a waiver would be unnecessary as the Fusion lamp complies fully with the rules governing these high frequency emitters. Unfortunately, however, because of a definitional scheme that is based on early technology, the Fusion lamp is governed by outdated rules for low frequency lighting devices.

Under Part 18, RF lighting devices are required to show compliance with conducted emission limits below 30 MHz, necessitating the use of expensive filters to "choke off" low frequency emissions on the power line. Fusion has discovered that if it installs commercially available line filters which are capable of meeting Part 18, its lamps will fail the safety standards administered by Underwriters Laboratories (UL). Since UL cannot compromise end user safety (nor would Fusion want it to) the Commission's rules alone determine the commercial viability of this new lighting technology.

II. The RF Lighting Device Rules were Never Intended to Apply to Microwave Lamps

Fusion's lamp may be described as a device that meets the definition of an RF lighting device but has the operating characteristics of a microwave oven. The Commission's Part 18 rules were never intended to govern such an ISM product.

First discussed by the Commission in 1976,^{3/} RF lighting devices were one of several then emerging domestic ISM technologies (the others were induction ranges and microwave ovens) for which the Part 18 standards "were never intended to

^{3/} Notice of Inquiry, Docket No. 20718, 58 FCC 2d 636 (1976).

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apply."^{4/} Among other things, the Commission regarded Part 18 to be inappropriate for ISM products used in commercial and residential locations because most ISM equipment contained no limits or emissions conducted over power lines. Accordingly, the Commission began a rulemaking to revise its Part 18 rules in Docket 20718, and to create a new category of "consumer ISM" with a uniform set of radiated and conducted limits.^{5/}

Urgent to get RF lighting to the market, the Commission granted limited waivers of the Part 18 rules to the General Electric Company ("GE") and three other bulb manufacturers soon after Docket 20718 began.^{6/} All of these lighting products claimed to be three to four times more energy efficient than incandescent and conventional fluorescent lighting with five times the useful life. While each varied in its approach to "RF ballasting," their fundamental emissions were confined to the range of 10 KHz to 80 MHz. Accordingly, the Commission imposed a condition for waiver that these new RF lighting products comply with the technical requirements for computing devices which had then just recently been developed.^{7/} Shortly thereafter, the Commission began a separate Notice of Inquiry in Docket No. 83-806,^{8/} to seek further information on the EMC characteristics of RF lighting technology. Eventually, Docket 20718 was amended to include new rules for RF lighting devices, based on the limits

^{4/} Notice of Inquiry, Gen. Docket No. 83-806, 48 FR 37235, ¶9.

^{5/} Notice of Proposed Rulemaking, Docket No. 20718, 68 FCC 2d 876 (1979).

^{6/} See Order Granting Limited Waiver, FCC 80-418, 45 Fed. Reg. 51649 (July 23, 1980); Order Expanding Limited Waiver, FCC 81-25 (January 29, 1981); Order Granting Limited Waiver, FCC 83-361 (released Aug. 5, 1983).

^{7/} Id. See also, Memorandum Opinion and Order, 58 RR 2d 1283, at ¶4 (1985).

^{8/} See Notice of Inquiry, Gen. Docket No. 83-806, FCC 83-360, 48 Fed. Reg. 37235 (released Aug. 5, 1983).

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for computing devices,^{9/} which are the rules that are in effect today.^{10/}

During the Docket 20718 and 83-806 proceedings, which lasted nearly 10 years, RF lighting was discussed solely in the context of the low frequency devices governed by waivers. No industry comments or Commission discussions even considered the adoption of limits above 960 MHz for RF lighting, which was the highest frequency then applicable to computing devices. As the record debate discloses, all discussions focused on low frequency concerns.

This fact was recently made clear in a letter sent to the Commission from the National Telecommunications Information Administration (NTIA), a branch of the Department of Commerce, urging that the RF lighting rules be reviewed for emissions above 1 GHz because, "until recently, RF bulb technology had been developed at lower frequencies."^{11/} NTIA warned the Commission that "development of [RF lighting] technology had reached a stage where timely regulatory guidance is essential." Until the development of the Fusion lamp, therefore, the Part 18 rules have never had to anticipate the development of a 2.45 GHz lighting device.

III. RF Lighting Device Conducted Emission Limits Cannot be Met Safely or Economically by Microwave Lamps

If the Fusion lamp is required to comply with the Part 18 conducted emission limits it will fail to meet the UL safety standards, effectively removing it from the market. Should Fusion manage to find a solution to the EMC versus safety

^{9/} See Third Report and Order, Gen. Docket 20718, FCC 85-445 (released Aug. 21, 1985), 50 Fed. Reg. 36061 (1985). See also Erratum in Docket 20718 (released Aug. 29, 1985).

^{10/} The Commission subsequently considered, but rejected, a request that RF lighting devices meet radiated emission standards below 30 MHz. See Report and Order, Gen. Docket No. 83-806, FCC 87-325 (released Nov. 2, 1987).

^{11/} See Letter of April 12, 1995, to Richard Smith, Chief, Office of Engineering and Technology, from Richard Parlow, Associate Administrator, NTIA.

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"tradeoff" it will only come at a cost so great that the lamp will lose much of the competitive advantage that it expects to enjoy.

As Fusion recently discovered, the commercially available line filters which are capable of achieving the Part 18 limits^{12/} when introduced into the power line for a Fusion lamp, produce a leakage current that exceeds UL 923^{13/} and/or they provide a maximum temperature rating that is well below the operating environment in which the lamps will be installed.

The EMC versus safety dilemma is not new to the Commission, having surfaced in previous rulemaking proceedings involving consumer ISM devices. In Docket 20718, for example, the induction range manufacturers identified a current leakage problem with power line filtering, and the Commission provided a slight reduction (8 dB) in the conducted limits for these devices.^{14/} Later, in Docket 83-806, the Commission acknowledged the potential safety issue associated with the RF

^{12/} Part 18, requires the following conducted emission limits for RF lighting:

<u>MHz</u>	<u>Consumer (uV)</u>	<u>Non-Consumer (uV)</u>
.45 - 1.6	250	1000
1.6 - 30	250	3000

^{13/} UL 923 is a safety standard for microwave cooking appliances. UL does not have a standard that is designed for microwave lighting. UL 923 specifies a leakage current of .75 ma for a fixed appliance rated at 20 amperes or less. Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conduction surfaces and ground or other exposed conductive surfaces. During heat-up or cool-down this limit may be exceeded for sheathed heating elements, however, at no time shall the leakage current exceed 2.5 ma.

^{14/} One manufacturer calculated that the Commission's original proposal would add \$80-\$100 to the cost of a range. Id. at ¶12.

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lighting standards as it justified the use of higher emission levels for non-consumer devices.^{15/}

Unique to microwave lamps, however, are the safety issues associated with line filter temperature rating. For Fusion lamps to be UL listed, they must comply with the temperature rating specified by the line filter manufacturer. Under UL procedures, the temperature rating must be entered in its listing records, making it an express safety requirement for the device. Therefore, unless Fusion can procure a line filter that not only meets FCC Part 18 and UL 923 but also is rated for the environmental temperature in which its lamps will operate, it cannot produce a device that complies with the required standards.

As it turns out, none of the commercially available line filters examined by Fusion are rated above 60°C. These filters, however, must be installed inside the lamp's power supply where the operating temperatures will range between 80 and 90°C -- temperatures that greatly exceed the rated maximum required for UL listing.^{16/} Without UL listing, Fusion's lamps will not be accepted in the market.

IV. Microwave Ovens Have Never Been Required to Employ Line Filtering and Neither Should Microwave Lamps

Prior to the revision of Part 18 begun in 1978, the only ISM devices that were required to meet conducted emission limits were ultrasound medical devices. Line filtering was

^{15/} Memorandum Opinion and Order, Docket 83-806, FCC 88-298 (released Oct. 20, 1988). The amount of suppression needed for non-consumer devices would usually result in excessive levels of current leakage in the device and create potential shock hazards for users." Id. at ¶14.

^{16/} Because microwave ovens have never been required to filter their power line emission, the market has never had to develop a low cost filter capable of meeting both EMC and safety. Even so, the high ambient temperatures associated with microwave lighting would not likely be addressed by microwave oven filters.

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imposed on these products in 1955^{17/} due to their low frequency of operation (below 1 MHz) and potential source of interference to standard broadcast reception. All other ISM devices, including the evolving consumer ISM products like microwave ovens, were subject only to radiated emission limits above 30 MHz.^{18/}

In 1976, when the Commission became concerned that new types of consumer ISM might be creating potential interference not addressed by the Part 18 rules, it sought to rectify the situation by creating a new category of ISM for which conducted emission limits would apply. Based on industry comments, the Commission issued an Order in Docket 20718,^{19/} adopting regulations only for induction cooking ranges "in order not to delay marketing" of these new products;^{20/} specific rules for microwave ovens and RF lighting devices were deferred pending further proceedings. Microwave oven manufacturers who commented in the Commission's docket generally opposed any conduction limits because, they asserted, such limits would impose a "cost penalty" on their products.

^{17/} See Order, Docket No. 11031, FCC 55-113 (adopted Jan. 27, 1955).

^{18/} The only ISM equipment category containing true conducted emission limits was that of ultrasonic equipment; industrial heating equipment required filtering between itself and power lines to attain certain radiated limits from those lines; arc welders followed industrial heaters; and medical diathermy equipment was required to utilize "a rectified and filtered plate power supply, power line filters and sufficient shielding so that the emission of [RF] energy generated by such operation, including spurious and harmonic emissions, shall not exceed a strength of [15 uV/m @ 1,000 ft]" on the frequencies allowed for such operation. 47 C.F.R. §18.141 et. seq. (Nov. 1963).

^{19/} See First Report and Order, Docket 20718, 45 RR 2d 1719 (1979).

^{20/} Conducted emission limits were viewed as essential for induction ranges to protect AM radio reception because of the very low frequencies at which the ranges operated (20-40 KHz).

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In 1984, the Commission proposed a new set of Part 18 revisions in Docket 20718,^{21/} including radiated and conducted limits but only for RF lighting devices; ironically, the Commission abandoned the idea of "consumer ISM equipment," deciding to hold any new technical standards "in abeyance" due to the complexity and time involved in reanalyzing ISM equipment limits and because of parallel work ongoing by CCIR and CISPR.^{22/} The final Order^{23/} in Docket 20718 adopted limits for RF lighting devices and effectively "restored" microwave ovens to the 1963 standards governing "miscellaneous ISM." In 1991, the Commission began yet another ISM proceeding to determine the desirability of harmonizing Part 18 with CISPR Publication 11.^{24/} This docket is currently pending.

For 20 years -- 1976 through today -- the Commission has been virtually in a continuous rulemaking on the subject of microwave oven emissions. During this time, two critical facts have repeatedly surfaced, yet remained unchallenged: microwave ovens have never been identified as a source of harmful interference to radio reception^{25/}; and IEC/CISPR is the preferred forum for developing worldwide emission limits for 2.45 GHz ISM devices.

^{21/} Third Notice of Proposed Rulemaking, Gen. Docket 20718, FCC 84-578, 49 Fed. Reg. 47260 (adopted Nov. 21, 1984).

^{22/} CCIR is the French acronym for International Radio Consultative Committee, an arm of the International Telecommunication Union (ITU). CISPR is the French acronym for International Special Committee on Radio Interference, an arm of the International Electrotechnical Commission (IEC).

^{23/} Third Report and Order, Gen. Docket No. 20718, 58 RR 2d 1096 (1985).

^{24/} Notice of Inquiry, ET Docket No. 91-313, 6 FCC Rcd 6501 (1991).

^{25/} NTIA conducted studies on microwave oven emissions over a two year period, focusing mainly on emissions above 1 GHz where new radio services are being developed. No data or other evidence was reported in these studies to suggest that 2.45 GHz ovens were a source of interference to any existing spectrum users. See NTIA Report 94-303-1, 94-303-2, and 95-323 (August 1995).

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The Fusion lamp is beginning to undergo production for commercial and industrial sale. Domestic versions of the lamp are still under consideration and when these emerge, will likely appear in specialty products rather than light bulb replacements. The potential interference concerns from these lamps, therefore, will be dwarfed by the microwave oven emissions which operate on these same frequencies in millions of locations throughout the country. Under these circumstances, it is incumbent on the Commission to apply the same Part 18 standards to the Fusion lamp that are currently applied to microwave ovens.^{26/}

V. The Fusion Lamp Qualifies for a Waiver Under Section 1.3 of the Commission's Rules

It is well established that the Commission may grant a waiver of its rules "when good cause is shown and when to do so would not undermine the policies embodied in the rule."^{27/} A grant of Fusion's request would not undermine the Commission's goal of preventing harmful interference to radio reception from ISM devices because the Fusion lamp presents considerably less of an interference threat to radio receivers than the millions of microwave ovens currently on the market for which no interference problems are known to exist.

The Fusion lamp is capable of complying with the radiated limits for RF lighting devices up to 1000 MHz and with

^{26/} Conducted limits should only be applied in the case of a Class B digital device associated with the ISM device. An example is the controller circuitry for an oven. According to FCC Laboratory engineers, the oven's magnetron is not operated during verification testing of these components.

^{27/} In re Application of San Francisco Giants, DA 90-1211, ¶ 4 (released Sept. 18, 1990). See P&R Temmer v. FCC, 743 F.2d 918, 929 (D.C. Cir. 1984) (an agency "has an obligation to seek out the 'public interest' in particular matters and individualized situations") (emphasis in original); WAIT Radio v. FCC, 418 F.2d 1153, 1157 (D.C. Cir. 1969), cert. denied, 409 U.S. 1027, 93 S. Ct. 461 (1972) (agency has discretion to grant waivers).

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the miscellaneous ISM device limits, as well as CISPR limits,^{28/} above 1000 MHz.^{29/} Fusion's effort to bring its lamps into compliance with Commission and international EMC standards is a factor that should be weighed favorably in its request.^{30/}

In a similar situation in 1994, GE requested a limited waiver of the Part 18 conducted limits in the 2.2 - 2.8 MHz region for its new RF lighting device. GE asserted that the cost of compliance for power line filtering outweighed the benefits from complying with the rules. Despite objections from other RF lighting manufacturers the Commission granted GE's request, holding that "the potential public benefit of having additional consumer access to energy-efficient and cost-effective lighting products outweighs [the industry's] objections".^{31/}

In Fusion's case the basis for a waiver is even more compelling. Here, the application of the Part 18 limits for RF lighting devices impacts the Fusion lamp in a manner that was neither foreseen nor intended by the Commission when these rules were adopted. Unlike the GE device, which differs only slightly from the 1980's technology on which the original RF lighting waivers were based, Fusion's lamp is truly unique both in terms of spectrum usage and efficiency. Moreover, Fusion's lamp presents none of the environmental hazards associated with the mercury-laden GE devices.

^{28/} Although "out-of-band" emission limits above 1 GHz are being developed by IEC/CISPR at the international levels, these efforts are intended to prevent interference to high frequency radio systems under development, not to correct interference problems from ISM sources.

^{29/} The FCC Laboratories sample tested the Fusion Solar 1000 lamp and confirmed this to be the case.

^{30/} See In the Matter of Electra Co., FCC 85-7, ¶ 7 (released Jan. 16, 1985) (granting waiver of Part 15 rules where applicant had demonstrated "effort to come into complete compliance with the new regulations"). But see In the Matter of AT&T Co., 52 RR 2d 1416, 1417, at ¶ 7 (1982) (denying waiver request where applicant had failed to show that it was in partial compliance with the rules).

^{31/} See Letter of October 23, 1995 to D. Zeifang from William F. Coton, Acting Secretary, FCC.

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A grant of Fusion's request will clearly serve the public interest by making available a revolutionary lighting technology that offers a manifold increase in lighting efficiency over existing products. In previous situations where it could be shown that little or no interference will result and the public will benefit from new advances in technology, such waiver requests have been routinely granted by the Commission.^{32/} For these reasons, Fusion's microwave lamp qualifies for a waiver of the Part 18 rules.

VI. The Chief Engineer has the Delegated Authority to Grant Fusion's Waiver Request

Under Section 0.241(a)(3) of the Commission's rules,^{33/} authority has been delegated to the Chief Engineer to rule on petitions for waiver where such requests do not contain new or novel arguments not previously considered by the Commission, or present facts or arguments which appear to justify a change in Commission policy. On several occasions, moreover, the Commission specifically granted authority to the Chief Engineer to issue waivers similar to the one Fusion is requesting.

In 1983 the Commission delegated authority to the Chief Scientist to grant waivers of the Part 18 rules to any manufacture who could meet the condition established in the original GE RF lighting waiver petition.^{34/} Such manufacturers were required to demonstrate compliance with the emission standards that were more liberal than other ISM products. More recently, the Commission again delegated authority to the Chief Engineer on a RF lighting matter, this time for the purpose of extending or reducing the effective period of the current GE waiver based on the "operating" experience of the device. In that case, as well as the one here, the waiver request dealt with

^{32/} See e.g., In the Matter of Semstar Security, 52 RR2d 1490 (1983); In the Matter of Sielox System, FCC 87-107 (released April 15, 1987); In the Matter of Control Data Corporation, FCC 85-426 (released Aug. 2, 1985).

^{33/} 47 C.F.R. §0.241(a)(3).

^{34/} See Order Granting Limited Waiver, supra note 5, at 5.

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a need for relief from overly stringent conducted emission limits for emerging energy efficient lighting technologies.

Fusion's waiver request provides no arguments that have not previously been considered and accepted by the Commission, nor does it raise any novel questions of law requiring a change in Commission policy. A grant of Fusion's request by the Chief Engineer would be entirely consistent with nearly 16 years of well-established precedent to relieve RF lighting manufacturers from unnecessary and burdensome conducted emission requirements in the Part 18 rules.

Conclusion

Based on the foregoing discussion, Fusion respectfully requests a waiver of the conducted emission limits set forth in Section 18.307(c) of the Part 18 rules for its microwave lighting devices.

Very truly yours,



Terry G. Mahn

TGM/smw

cc: Bruce A. Franca, Deputy Chief Engineer
Julius Knapp, Chief, Equipment Authorization Division
L. Art Wall, Chief, Consumer Service Branch
John A. Reed, Technical Rules Branch
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